UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

28

January 9, 1930

DEVELOPMENT OF MORE EFFICIENT EQUIPMENT FOR THE TREATMENT OF STANDING INSECT-INFESTED LODGEPOLE PINE

BY

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Insect Control

TESTS OF NOZZLE EQUIPMENT TO THROW FUEL OIL ON TREES IN INSECT CONTROL WORK BY BURNING STANDING METHOD

On March 6, 7 and 9, tests were carried out with fuel oil and with Banner sprayers manufactured by D. B. Smith Company to determine the best type of nozzle equipment for use in throwing oil on trees in insect control work. In the first test on March 6, nozzles similar to those furnished by D. B. Smith Company in the fall of 1929 were used as furnished with a somewhat larger bore, with a cylindrical section at the end and tapered entirely to the point. A check was made with nozzles tested at the Coeur d'Alene Forest Insect Field Station. These were numbered specifications 1, 2, 3, and 4 and the regular nozzle furnished early last year, which is short with an opening of size 55 drill. The following description is given for these nozzles:

Spec. 1. This nozzle was designed by the D. B. Smith Company. It is 1-3/4 inches in length and has an aperture of approximately 0.07 of an inch in diameter. The bore is about 1-1/4 inches in length and is tapered from an opening at the base of about 3/16 of an inch in diameter to the aperture.

Spec. 2. A nozzle designed at the Coeur d'Alene Station. It is 1-1/4 inches in length and has an aperture of 0.06 of an inch in diameter. The straight bore is 3/4 of an inch in length, starting from a rather abrupt, slightly tapered shoulder at the base of the nozzle.

Spec. 3. Designed at the Coeur d'Alene Station. A length of brass pipe 1-1/4 inches in length, with a bore of 0.07 of an inch in diameter, was soldered to one of the standard D. B. Smith nozzles. This adaption merely added the long straight bore to the D.B. Smith nozzle.

Spec. 4. Designed at the Coeur d'Alene Station. This nozzle is the same as Spec. 3, except for the brass pipe which has a bore of 0.06 of an inch in diameter.

The results of this test are given in Table 1. This was not wholly satisfactory in that a disagreeable gusty wind made the readings somewhat uncertain. The object of this test was to determine the superiority of any particular shape or form of nozzle. It will be seen here that used with gas oil the nozzle tapered entirely to the end gave slightly better results but not sufficiently better than any of the others to give very much preference. It was also noted that with using oil the pressures indicated for maximum results were considerably lower than in the tests at the Coeur d'Alene field station.

The following day additional tests were made under more favorable wind conditions and these are given in Table 2. The results of this second test indicated that the regular nozzle was only slightly less effective than the one tapered entirely to the end. In fact, local variations in the reach made it difficult to choose between these two. It was clearly indicated that everything considered there was not enough advantage to justify a change in nozzle design. The general conclusion was that the shape of the nozzle as put out in the fall of 1929 was satisfactory.

The third test was made in order to determine for a given nozzle design just what the effect on reaching power would be from a variation in the size of the opening. The results of this test as given in Table 3 indicated definitely that the No. 55 bore for use with gas oil was the most satisfactory. Although these tests are not exhaustive in the number of observations taken, many of the figures entered are averages of a considerable number of tests. Where there was no indication of advantage in carrying observations out in greater detail such were not extended. A number of observers were present and were all agreed regarding the conclusions reached. The men most concerned in the tests were Mr. E. B. Davenport of the Fire Protection Engineering Company, Ranger Lemuel Steele of the Targhee Forest and S. B. Locke of the District Office.

A light pole with clear cut marks at one foot and half foot lengths were placed beside a telephone pole in the center of a vacant lot and excellent observations could be made as to the exact distance the oil was thrown. A tire valve was fastened to the tanks used in the test and pressures taken from a tire gauge for balloon tires.

Tests made with the extensions indicated that practically the full length of the extension could be gained in reach and that slight, if any, additional pressure was needed. It is believed that oil pressures in excess of 25 pounds are wasted and that the most effective results will be obtained at pressures slightly below 20 pounds.

S B Locke

District Forest Inspector.

Table 1.

Tests with Banner Sprayer and Gas Oil - Gusty Wind During Test

March 6, 1930

Lbs. Pressure	Nozzle Type	As furnished fall 1929					As made for tests by Evenden				
	Nozzle Number	No. 1 Tapered	No. 2 1/2" Straight	No. 3 Regular	No. 4 3/64	No. 5 Regular	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Reg. short nozzle
	Diam. in In.	.052	.052	.052	.047	.052	.07	.06	.07	.06	.052
15	Height in Ft.	21.5									
20		21.0	19	19.5	19	19	20.0	19.5	19	19.5	18
30		20.5		20.0	20	20	20.5	20.5	20	19.0	19
35		X									
40			20	X	X18	X19	X 19.0	X12.0	X18	X18.0	X18
	With 10 ft. extension										
30		28.0									
35		25.5									
40		X									

X Blows to spray.

Table 2

Tests with Banner Sprayer and Gas Oil - Light Wind

March 7, 1930

Lbs. Pressure	Nozzle Type	As furnished fall 1929					As made for tests by Evenden					
	Nozzle Number	No. 1 Tapered	No. 2 1/2" Straight	No. 3 Regular	No. 4 3/64	No. 5 Regular	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Reg. short	Reg. short
	Diam. Inches	.032	.052	.052	.047	.052	.07	.06	.07	.07	.052	.07
15	Hgt. in Feet	20.7			19.5							
18		21.5		22.5			21					
20		22+	18.5	21.5	22.5		22	19	21+			
25		21.5	19.5	22+	21.0		22	22	20.5	22	X	
30		X			19.0							
	With 10 ft. extension											
20		30.5		30.5								
25		30.0		30+			28.5			27.5		
30				30+								

No. 1 at 25 lbs. pressure flows 1/3 gallon in 1'32" or .32 gallons per min. pressure falling to 18 lbs.
No. 3 " " " " " " " 1'55" " .26 " " " " " " 16 "
Spec. 1 at 25 lbs. pressure " " " .54 " " "

X Breaks into spray

Table 3.

Tests with Banner Sprayer and Gas Oil
All with nozzle as prepared fall of 1929 by D.B.Smith Company with various size openings.

March 9, 1930

Lbs. Pressure	Drill Size	No. 50	No. 52	No. 53	No. 55 °
	Size Inches:	.07	.063	.0595	.052
	Height:				
15	Feet	19	21.3	21.0	21.2
18		21+	20.5	21 -	21.2
20		19.5	20.5	20.0	20.5
25		18.0	19.5	20.5	21.5
Time to flow 2 quarts		52"	1'5"	1'16"	1'35"
Gals. per min.		.577	.461	.395	.315
Drop in pressure:	Begin	20	20	20	20
	End	13.5	13	14.5	13.5

° Throws heavy stream spreading widely and wasting oil.

M1-10

Forest Insect Field Station,
Coeur d'Alene, Idaho,
January 9, 1930.

MEMORANDUM - DISTRICT FORESTER, OGDEN, UTAH

Re - Development of More Efficient Equipment for the Treatment of Standing Insect-Infested Lodgepole Pine.

The method of treating standing lodgepole pine trees infested with barkbeetle broods by spraying an inflammable oil upon the bole and then burning has been rather economically developed within the National Forests of District 4. This treatment results in the destruction of the developing insects under the bark on that portion of the trunk which is severely scorched by the flames. To secure a thorough treatment of tall, clean-boled trees, which are often infested to a height of 40 to 50 feet or over, more satisfactory pumping or spraying equipment than has been used in the past must be developed. It is necessary that equipment be secured that will throw a fine, fairly solid stream of oil to a height of at least 30 feet, if the method is to be considered as being satisfactory and thorough. If the oil can be thrown to such a height, which will be well into the limbs of nearly all trees, the flames will crown out through the top and a 100 per cent treatment will be secured. To assist in the development of such equipment the following tests were conducted at the Coeur d'Alene Station, Bureau of Entomology.

With the idea that this problem consisted in obtaining a proper correlation between pressure and nozzle, and that a satisfactory nozzle could be developed which would give the desired results with a relatively low tank pressure, a series of tests were made of a number of nozzles at different pressures. In conducting these tests the height of stream, most efficient pressure, and the per minute deliverance in gallons of each nozzle, were considered. A Banner Spray Pump, manufactured by the D.B. Smith & Co. of the type used in connection with the control operations last spring, and a wheelbarrow spray outfit with which a pressure of 200 pounds could be secured were used in connection with these tests. The nozzles used were a series of the standard type provided by the D.B. Smith Co. with the Banner pump but with different sized apertures, together with others which were developed at this station. A description of the special nozzles follows.

SP -1 This nozzle was designed by the D. B. Smith Company. It is 1 3/4 inches in length and has an aperture of approximately 0.07 of an inch in diameter. The bore is about 1 1/4 inches in length and is tapered from an openring at the base of about 3/16 of an inch in diameter to the aperture.

SP -2 A nozzle designed at the Coeur d'Alene Station. It is 1 1/4 inches in length and has an aperture of 0.06 of an inch in diameter. The straight bore is 3/4 of an inch in length, starting from a rather abrupt, slightly tapered shoulder at the base of the nozzle.

SP -3 Designed at the Coeur d'Alene Station. A length of brass pipe 1 1/4 inches in length, with a bore of 0.07 of an inch in diameter, was soldered to one of the standard D. B. Smith nozzles. This adaption merely added the long straight bore to the D. B. Smith nozzle.

SP -4 Designed at the Coeur d'Alene Station. This nozzle is the same as SP - 3, except for the brass pipe which has a bore of 0.06 of an inch in diameter.

SP -5 Designed by the D. B. Smith Company. Nozzle is 2 1/4 inches in length and has an aperture of 0.059 of an inch in diameter. The bore is 1 3/4 inches in length and is tapered from a basal opening of 1/4 inch in diameter to the size of the aperture at a point 1/4 inch from the tip of the nozzle, where the channel becomes straight.

The following table shows the results secured by using the Banner spray pump with a pressure gauge attached:

Table I

Data Secured with Banner Spray Pump

Lbs. Pressure	Nozzle No.	46	50	52	55	60	SP.1	SP.2	SP.3	SP.4	SP.5
	Diameter of Aperture	.081"	.07"	.063"	.052"	.04"	.07"	.06"	.07"	.06"	.059"
20	Height in Feet:	21*	20*	21	--	19½	22	22	20	21	22½
	Gals. per Min.:	.777	.597	.365	.333	.196	.612	.506	.469	.375	.396
25	Height in Feet:	--	--	23	23	21*	26	24	22	21½	20*
	Gals. per Min.:	--	--	.386	.288	.167	.684	.513	.524	.310	.459
30	Height in Feet:	--	--	24	24	--	27	24*	24⅓	22	22*
	Gals. per Min.:	--	--	.412	.311	--	.704	.598	.551	.449	.469
35	Height in Feet:	--	--	25	24	--	29	--	25	22	24*
	Gals. per Min.:	--	--	.452	.336	--	.762	--	.589	.478	.513
40	Height in Feet:	--	--	25	24	--	29*	--	25	23	24*
	Gals. per Min.:	--	--	.454	--	--	--	--	624	--	--

* Stream broke into spray.

From the above table it will be seen that the greatest height was secured with nozzle SP -1. A height of 29 feet was secured at a tank pressure of 35 pounds, but the stream was large and resulted in a deliverance of 0.76 gallons per minute. Though the height secured and the pressure required were very satisfactory, the heavy discharge would make the use of this nozzle very expensive due to the wastage of oil. A height of 25 feet was secured with SP -3 at the same pressure and with a very satisfactory discharge of 0.58 of a gallon per minute. The other nozzles used in this test were not at all satisfactory as either insufficient height was secured or else, as with SP -5, the stream broke into a spray.

Table II

Data Secured with Meyers Wheelbarrow Spray Pump

Tank Pressure	Nozzle Number and Diameter																			
	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.	No.	Dia.
	43	.089	46	.081	50	.07	52	.063	55	.052	56	.046	60	.04	SP.1	.07	SP.2	.06	SP.3	.07	SP.4	.06
50 lbs.	29		26		26		25		24		26		24		31*		28*		26*		25	
60 "	30		24		25		26		26		25		25		32*		--		27*		27	
70 "	30		24		27		26		25		23		25		32*		--		--		--	
100 "	30		25		24		26		--		--		25		26*							
125 "	30		25		25																	
150 "	30		27		25																	
175 "	30		28		26																	
200 "	30		28		26																	
Gals. per Min.	1.6		0.9		0.85		0.44		0.34		0.47		0.26		0.88				0.66		0.50	
At Most Efficient Pressure	60 lbs.		50 lbs.		70 lbs.		40 lbs.		50 lbs.		50 lbs.		60 lbs.		60 lbs.				50 lbs.		50 lbs	

* Stream broke into spray.

From Table II, where the higher pressures were secured with the wheelbarrow pump, it will again be seen that the greatest height (32 feet) was secured with SP -1 at a pressure of 60 pounds. With this nozzle and the increased pressure the discharge increased to 0.88 of a gallon per minute, which would practically prohibit its use. SP -3 gave the next best results with a height of 27 feet, at the same pressure of 60 pounds, and a discharge of 0.66 of a gallon per minute. However, at this pressure the stream from this nozzle broke into a rather bad spray which would make its use unsatisfactory. Nozzle SP -4 would seem to give the best results as a height of 27 feet was secured with the 60 pounds pressure, and the discharge was only 0.50 of a gallon per minute. The results secured with SP -4 would seem to fit the requirements of the problem fairly satisfactorily, if a pressure of 60 pounds could be secured with the Banner pumps or any other portable equipment of this type. It will also be seen from Table II that there is a distinct correlation between the nozzle and pressure, and that additional pressure above the point of maximum efficiency has no beneficial effects and in most cases results in the breaking of the stream into a spray.

Table III

Table Showing Results Secured with a Banner Spray Pump and the Addition of a Six-foot Brass Pipe Extension.

Pressure in Lbs.	No. 52		No. 55		No. SP. 1		No. SP. 3		No. SP. 4		No. SP. 5	
	A	B	A	B	A	B	A	B	A	B	A	B
25	23	25	23	25	26	29	22	26	21	24	20	24
30	24	29	24	26	27	30	24	26	22	25	22	26
35	25	30	24	28	29	32	25	27	22	25	24*	27
40	25	30	24	30	29*	32*	25*	31	23	26	24*	31
50	25	30	24	27*		31*		30*	25	30	23*	26*
Gals. per Min. of Greatest Height of Stream	.452		.340		0.762		0.624		0.500		0.560	

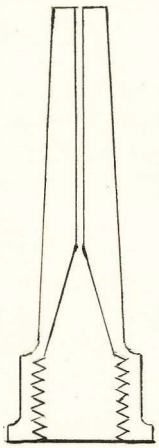
A - Height of stream without extension
B - Height of stream with 6-foot extension
* Stream breaks into spray.

The extensions used in connection with the above tests were commercial 36-inch brass extensions manufactured by the D. B. Smith Company. They are very light and would be reasonably easy to carry. From the above tabulation it will be seen that nozzle SP -4 gave an increased height of 5 feet, or 30 feet in all, at a pressure of 50 pounds, which can be secured with the Banner pump. The discharge from the nozzle on this equipment remained the same as for the other tests, 0.50 of a gallon per minute.

It is fully realized, in presenting the results of these tests, that the data secured cannot be accepted as a final measurement of each nozzle's efficiency, inasmuch as water was used in all trials. In an actual field demonstration an oil, which would no doubt vary considerably from water in specific gravity, surface tension, and viscosity, would be used. Though such properties of the oil used would perhaps enter more or less seriously into the solution of the problem, their importance and requirements are not thoroughly understood. As a result of this condition all tests have been made on a trial and error basis. However, from the data secured it is believed that a nozzle can be developed which will satisfy the requirements of these factors and give satisfactory results at a pressure that can be secured with a portable hand pump.

Attached to this memorandum is a sketch of the type of nozzle which is believed will give satisfactory results at a pressure of 50 pounds, which can be secured with portable hand pumps. It must be understood that this nozzle has not been tested, and a series of experiments will be necessary in order to determine the diameter of the straight bore which will most efficiently care for the oil being used. However, the writer feels satisfied that it is only from such a straight bore that a fine solid stream of sufficient height can be secured, regardless of the amount of pressure available. All shoulders should be eliminated from the base of the nozzle and the liquid should be led into the straight bore through a tapered chamber in order to reduce all possible friction and resistance. Further experimental work is necessary to adapt a nozzle to the different properties of the oil that is to be used, and to establish the proper correlation between such a nozzle and the required pressure.

James C. Evenden
Entomologist.



Actual size. Aperture 0.059".